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A TELEMETRIC STUDY OF NESTING FEMALE ALLIGATORS ON ROCKEFELLER REFUGE, LOUISIANA

by

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INTRODUCTION

This paper describes movements and activities of adult female alligators *(Alligator mississippiensis)* and attempts to evaluate this data in order to formulate management practices for the species.

Due to excessive hunting pressure, Louisiana's alligator population has been declining since the mid 1930's. This decline in the population was primarily brought about as a result of the systematic exploration of the natural resources in the coastal marshes of the state. Canals were dug into the remote areas of the marshes in the development of various oil and gas leases. In a relatively short period of time this development was expanded to include a network of canals along the entire Louisiana coast. This network of waterways provided hunters and trappers convenient access into the more remote marshes for the purpose of hunting alligators and trapping fur-bearing animals. During periods of drought, alligators would come to these canals and would be killed by the untold thousands (McIlhenny, 1935).

A species as vulnerable as the alligator could not withstand this indiscriminate killing and within a short period of time the alligator population was greatly reduced. Louisiana became aware of this population decline in the mid 1950's; however, only general management practices were known concerning this reptile. Protection was the main tool used in managing the population and in 1960 the first laws were passed aimed at protecting the alligator. A size limit and maximum season length was established in order to curtail some of this hunting pressure. In 1963, the season was closed statewide and enforcement activities were stepped up in order to afford the necessary protection. Also, a study was begun on Rockefeller Refuge in 1959 aimed at investigating some of the more important aspects of the alligator's life history.

Studies conducted on Rockefeller Refuge for the past few years have demonstrated that more information is needed on alligator movements and factors effecting movements before habitat management can be initiated. Also, in setting harvest regulations, alligators can be selectively harvested when the movements of certain segments of the populations are known. With this in mind, a telemetric study of nesting female alligators was conducted on Rockefeller Refuge during the summer of 1969. The objectives of the study were:

(1) To capture sexually mature female alligators and attach radio transmitters for the purpose of tracking with a portable receiver.
(2) To monitor daily and seasonal movements of individual alligators.
(3) To determine the minimum home range of individual alligators.
(4) To relate the movements to habitat preferences of the female.

It has become quite apparent in the past decade that radio telemetry can contribute significantly to the field of wildlife management. In Louisiana, Taylor (1969) found that minimum home range sizes for 13 eastern wild turkeys *(Meleagris gallopavo silvestris)* instrumented with transmitters ranged from 212 to 3,700 acres. Lewis (1968) reported that three deer *(Odicoileus virginianus)* exhibited minimum home ranges of 406, 555, and 762 acres when tracked with radio telemetry gear.

The use of radio telemetry allows a more comprehensive study of the alligator in its environmental niche than was possible using the conventional methods of marking and recapturing. Radio tracking provides an excellent means of collecting large quantities of timely movement data over an extended time period.

DESCRIPTION OF STUDY AREA

This study was conducted on Rockefeller Refuge in Southwestern Louisiana. The refuge is owned and operated by the Louisiana Wild Life and Fisheries Commission and encompasses some 85,000 acres of coastal marshland. It is bounded on the south by the Gulf of Mexico and on the north by the Grand Chenier-Pecan Island stranded beach ridge complex.

Rockefeller Refuge as a whole, excluding the impounded areas, is a wiregrass, *Spartina patens,* marsh.

Marsh elevation averages 1.1 feet above mean sea level. Tide water enters the refuge from the Gulf of Mexico through five separate channels and then spreads out to all parts of the refuge with the exception of the impounded areas. The average tidal variation is one foot; however, high tides frequently inundate the marshes with salt water.

The fresh marsh, a narrow belt adjacent to the Chenier, possesses the maximum water depths. Removal of water on the fresh marsh during the summer permits the germination of annual grasses. As a result, large stands of *Echinochloa walteri, Leptochloa fascicularis,* and *Panicum dichotomiflorum* frequently grow on exposed or shallow mudflats in the fresh marsh and produce seeds which are eaten in quantity by waterfowl.

More than 75 percent of the vegetation of the refuge is growing on brackish sites. This brackish area is dominated by wiregrass, *Spartina patens,* but contains some *Distichlis spicata.* The subclimax species, leafy three-cornered grass, *Scirpus robustus*, and three-cornered grass, *Scirpus olneyi*, are present but, the area occupied by these species is quite small.

The aquatic communities are composed chiefly of wireongrass, *Ruppia maritima,* dwarf spike rush, *Eleocharis parvula,* and *Potamogeton sp.* Wigeongrass is the only aquatic found in the salt marsh ponds. Some moist sites are dominated by sea purslane, *Sesuvium portulacastrum* (Joanen and Glasgow, 1965).

STUDY PROCEDURE

Telemetry Equipment

VHF tracking transmitters and receivers were constructed for this study by Sidney L. Markusen, Electronic Specialties, Esko, Minnesota. The transmitters were equipped with 8½ inch whip type antenna and emitted pulsed signals in the 150.100 to 151.210 megacycle range.

The transmitting components, batteries, and antenna were mounted on a neck collar attachment constructed of heavy rubberized fabric, which was 2¼ inches in width, 3/16 inch in thickness and adjustable from 18½ to 26 inches in circumference. Total weight of the transmitter assembly was about 21 ounces. Two mercury batteries, with an expected life of 8 months, provided the power source. The transmitters were encapsulated in epoxy resin which served as a waterproofing agent in addition to being sealed within an aluminum case.

Portable VHF tracking receivers with corresponding channels tuned to frequencies of the transmitters were used for the duration of this study. Two receivers, 100 percent transistorized, were used in order to minimize weight and battery drain. Ten size D flashlight batteries made up the power source for the receiver. A two element Yagi hand-held directional antenna was the only antenna used during this study. Total weight of the receiver, carrying box, earphones, and antenna was 14 pounds.

Aproximately two days before attaching the transmitter to the alligator, the transmitters were activated by soldering the two "hook-up) wires together. Exposed wiring was then wrapped with vinyl electrical tape in order to protect it from abrasion. The entire neck collar transmitter unit, with the exception of the antenna, was then dipped twice in coal tar epoxy (summer grade). This epoxy consisted of one part epoxy activator and four parts coal tar by volume and served as a waterproofing agent.

A Silva Ranger compass, with luminous points for night readings, was used for obtaining the compass bearings.

Pre-testing of Equipment

Prior to the initiation of the study, field tests were run to familiarize personnel with the equipment and also to get an idea of the effectiveness under actual marsh conditions. Maximum range was determined to be about 1½ miles. Signals were not detected as long as the antenna of a transmitter was submerged in water.

Tests were run to determine our effectiveness in locating a transmitter at different locations in the marsh. One man would move about in the marsh with a transmitter and the man with the receiver would then take "fixes" on him to determine the capabilities of the equipment and also to help develop our abilities in locating the units.

It was quickly noted that the closer the distance to the transmitter, the more difficult it was to get a "fix" due to the strength of the signal. Fine tuning of the receiver was critical at close distances.

Method of Capturing and Markng

All alligators used in this study were captured and tagged as described by Chabreck in an earlier report (Chabreck, 1963).

Transmitter Attachment

After waterproofing a transmitter and checking it to make sure it was functioning properly, the collar was adjusted to fit the neck of the alligator. Wooden strips were cut to fit laterally to the four dorsal neck scutes just posterior to the head and then attached to the collar with vinyl tape. These strips kept the collar in a fixed position with the antenna in an upright position on the dorsal part of the neck. Also, to insure that the antenna remained in its upright position, the collar was tied down with monofilament line threaded into small holes drilled through four scutes on the neck. The collar was attached by seating four Belknap pop rivits with backup spacers into prearranged holes located near the ends of the collar. Excess collar material was then trimmed off. Forty-five minutes to an hour was required to attach the collar. The signal emitted was checked prior to the release of each animal. During the period of attachment, a sack was placed over the head of the alligator and remained on each female until it was released in the marsh. The sack served to keep the alligator sullen or in a semi-relaxed state during the collaring process.

Establishing Stations

Fifteen permanent listening stations were established during the course of this study. Each station was numbered, marked with a wooden stake, and flagged for ease of location. The stations were located so that an outboard motor, or during periods of low water, an airboat could be manuvered to the stations. All of the compass bearings taken during the course of this study were made from these stations.

Tracking Procedure

Tracking of alligators was accomplished almost daily, with the majority of the readings being taken in the early morning hours, or late evenings and night. A directional reading or fix was obtained by setting the channel selector for a particular transmitter and revolving the hand-held antenna, with the elements perpendicular to the ground, in a 360° arc. When the strongest signal was located, a compass bearing was taken in direct line with the transmitter. The compass reading was then recorded in a field data book along with the time. This operation was repeated at other stations until at least two good signals, acceptable for triangulation, were received for each unit. Water depths in the marsh and general notes concerning weather were also recorded.

After the field phases of this study were completed, the data was plotted on a map reproduced from aerial photographs. The triangulation method was used to pin point the location of the alligators under study. These fixes were used to determine the movements and activities of the alligators reported for this investigation.

For classifying activities of the female during the study, movements were broken down into four separate time periods. These periods were set according to the activity, location of the female, and the amount of movement demonstrated during each period (Table 1).

The information presented in this report is based on a total of 411 compass bearings taken during the 177 day duration of field phases of the study.

Acreage figures were calculated by using both a K and E compensating polar planimeter and a modified acreage grid marketed by Forestry Suppliers, Incorporated, Jackson, Mississippi.

RESULTS AND DISCUSSION

Five alligators were studied using radio tracking gear during the period of May 18, 1969 through November 10, 1969 (Table 2). Fixes, representing 411

TABLE 1

DESCRIPTION OF MOVEMENTS OF FEMALE ALLIGATORS AS DETERMINED BY TELEMETRIC STUDY ON ROCKEFELLER REFUGE, 1969

Period	Activity	Date of Period	Number of Days	Location of Female
I	Courtship and Possible Breeding	5-18 - 5-31	14	*Open water areas
II	Nest Construction and Egg Laying	6-1 - 6-20	20	**Dens in marsh
III	Incubation Period	6-21 - 8-30	71	Dens in marsh
	Subperiod A	6-21 - 7-1	11	
	Subperiod B	7-2 - 8-30	60	
IV	Post Hatching	8-31 - 11-10	72	Dens in marsh

*Open water areas - bayous and canals, marsh lakes and ponds greater than one acre in size.

**Dens in marsh - dense marsh vegetation with small potholes less than one acre in size.

compass bearings, were taken on a total of 118 days within the 177 day study period. Transmitter life varied from a high of 177 days to a low of 15 days for the alligators included in this report. A summary of the movement data obtained during the study was broken down into four periods and is presented in Table 3.

Two terms used quite frequently in the discussion of this paper should be defined so that there will be no misconception concerning the terminology: open water areas refers to marsh lakes and ponds greater than one acre in size, bayous and canals; dens and potholes in marsh refers to dense marsh vegetation primarily *Spartina patens,* with small water areas less than one acre in size.

Movements of Individual Alligators

Alligator No. 3579. A seven foot ¾ inch female alligator was instrumented with transmitting Unit 4 on May 18, 1969. This alligator was monitored through November 10, 1969 and was found to have a minimum home range of 24.2 acres (Figure 1).

Period I - Courtship and Possible Breeding. During the courtship and breeding period, alligator 3579 exhibited a minimum range of 7.8 acres and was located in open water areas for 73 percent of the plotted locations made on her. Unit 4 later selected a nesting site within this area.

Period II - Nest Construction and Egg Laying. Locations plotted during the 20-day period which included nest construction and egg laying showed that Unit 4 almost completely moved out of the area used in Period I except for a portion of a lake and the general area of the nest site. However, the range of overlap, where the greatest amount of fixes were obtained for Periods I and II, was in a two acre area surrounding the nest site.

Plotted fixes showed that 78 percent of her activities during Period II were confined to small potholes and dens within a 13.6 acre marsh area.

TABLE 2

LENGTH, WEIGHT, AND IDENTIFICATION OF ALLIGATORS CAPTURED FOR RADIO TELEMETRY STUDY, ROCKEFELLER REFUGE, 1969

Date Instrumented	Tag No.	Mark	Weight (lbs.)	Total Length	Unit Number	Last Radio Contact
5-18-69	3579	DI-3	85	7′ ¾″	4	11-10-69
5-18-69	3578	DI-2	93	7′ 3″	8	9-17-69
5-18-69	3577	DI-1	73	6′ 10″	9	7- 4-69
5-28-69	3583	DI-4	105	7′ 10¼″	6	6-11-69
7-22-69	3580	DI-5	64	6′ 4¼″	1	11-10-69

TABLE 3

MINIMUM RANGE SIZE AND LOCATION OF FEMALE BY PERIODS FOR TELEMETRIC STUDY, 1969, ROCKEFELLER REFUGE

Period	Activity	Date of Period	Days in Period	Unit Number	Location (Percent)	Minimum Range (Acres)
I	Courtship and Breeding	5/18-5/31	14	4	+72.73	7.81
				8	88.89	6.22
				9	75.00	9.25
II	Nest Construction	6/1 -6/20	20	4	×77.78	13.55
				8	80.00	4.14
				9	82.35	2.07
				*6	100.00	0.64
III	Incubation	6/21-8/30	71			
	Subperiod A	6/21-7/1	11	4	×100.00	0.33
				8	100.00	0.33
				9	100.00	0.33
	Subperiod B	7/2 -8/30	60	4	×62.50	2.71
				8	73.70	5.75
				**1	100.00	6.22
IV	Post Hatching	8/31-11/10	72	4	×100.00	0.48
				***8	88.29	1.75
				1	100.00	3.03

*Lost radio contact 6/11/69
**Instrumented on 7/22/69
***Lost radio contact 9/17/69
+Open water areas
×Dens in marsh

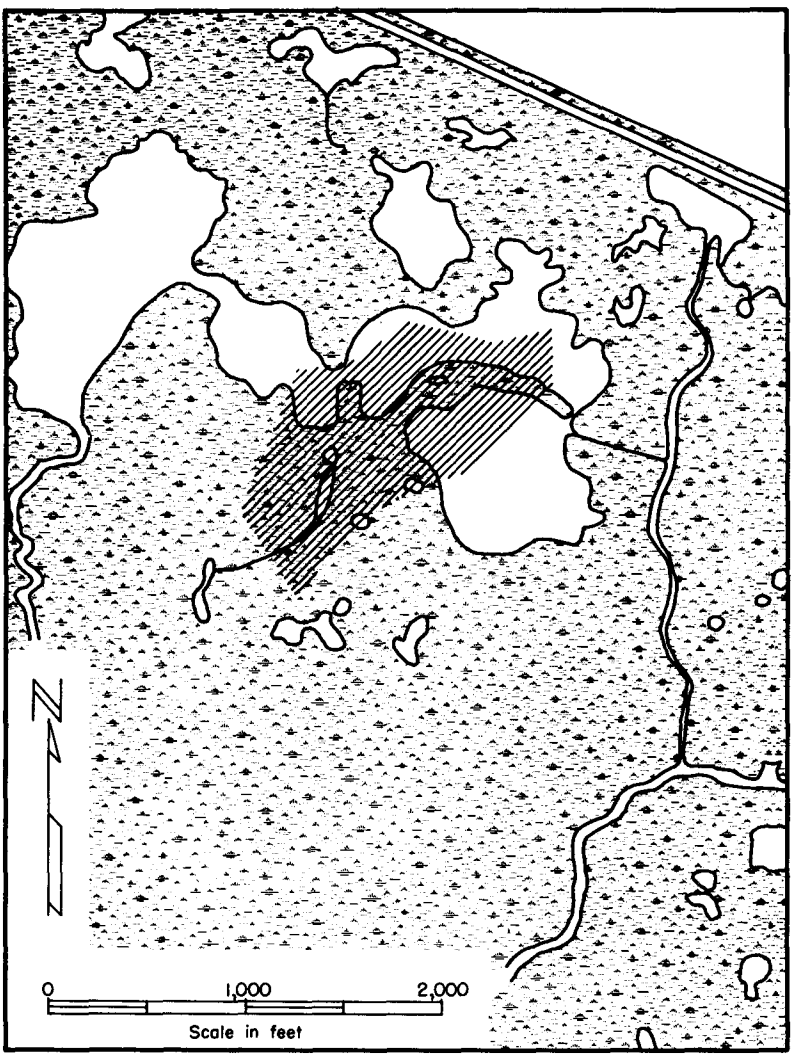

Figure 1. Minimum home range (24.2 acres) for alligator 3579 as determined by radio fixes from May 18 to November 10, 1969.

Period III - Incubation (Subperiod A). During the 11 day period immediately following nest construction and egg laying, Unit 4 was found to spend 100 percent of her time within a one-third acre area surrounding the nest site. This female was found to be located in several well established dens. The majority of her time seemed to be spent digging and enlarging these dens. On several occasions the female was seen by persons conducting this study as we approached the nest site. She was not aggressive nor did she make any attempt to protect her nest. This female would seek retreat into her den whenever humans approached her. From the turbid water in the dens and the muddy condition of the female it was assumed she was enlarging these cavities. Also, well defined trails were observed leading from the nest to various den sites.

Period III - Incubation (Subperiod B). Fixes plotted during the remainder of the incubation period showed this female had moved some 1,010 feet from her nest and 62.5 percent of her time was spent at dens in the marsh proper. Minimum range covered during this period was 2.7 acres. The female did not return to her nest site during the months of July and August. Seven hundred feet was the closest this female came to the nest during this period.

Period IV - Post Hatching. Movement was extremely limited during the 10 week post hatching period from August 31 to November 10. All fixes were located within a half acre piece of marsh. One hundred percent of her activities were plotted around an established den. The female did not return to the nest during Period IV. Alligator 3579 was plotted to be at least 900 feet from the nest during the entire post hatching period. November 10 was the last day that a radio signal was obtained for Unit 4 and it was suspected that this female entered winter dormancy in this area.

Alligator No. 3578. Alligator 3578, a seven foot three inch female was instrumented with transmitter Unit 8 on May 18, 1969. This unit functioned until September 17, 1969. Minimum home range determined for Unit 8 was 41.0 acres (Figure 2).

Period I - Courtship and Possible Breeding. During the courtship and breeding period, alligator 3578 maintained a minimum range of 6.2 acres and was located in open water areas on 89 percent of the fixes determined for her. The range of Unit 8 during this period was never any closer than 1,250 feet from where she later built her nest.

Period II - Nest Construction and Egg Laying. Locations plotted during the nest construction and egg laying period showed that 80 percent of the female's activities were confined to holes within a 4.1 acre area around the nest site. There was no overlap between areas used by Unit 8 in Periods I and II and as stated previously, these two areas were about 1,250 feet apart.

Period III - Incubation (Subperiod A). Unit 8 remained within a one-third acre marsh area surrounding her nest site during the 11 day period immediately following egg laying. During this period the female was located in several dens; however, she remained very seclusive during the entire period.

Period III - Incubation (Subperiod B). The range for this alligator during the remainder of the incubation period was 5.8 acres with 74 percent of her time being spent in dens in the marsh. Unit 8 did not return to the nest site during the months of July and August. The distance from the center of this late incubation range to the nest was 1,900 feet, with 1,650 feet being the closest alligator 3578 came to the nest site.

Period IV - Post Hatching. Movements from late August to September 17, when the unit went out, were confined to a 1.75 acre area. Eighty-eight percent of her activities during this period were confined to dens in the marsh. This alligator's movements for the post hatching period ranged from 1,600 feet to 1,950 feet from the nest. She did not return to the nest during this period.

Alligator No. 3577. A six foot ten inch female alligator was instrumented with transmitter number 9 on May 18, 1969. This unit operated until July 4,

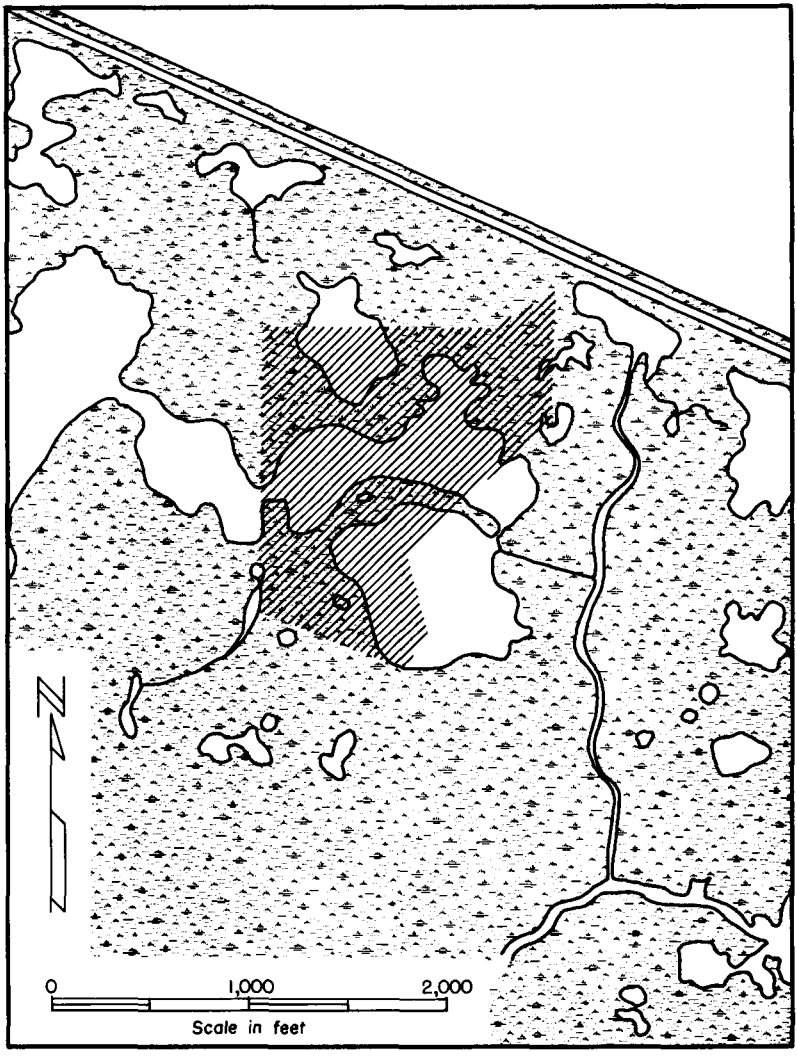

Figure 2. Minimum home range (41.0 acres) for alligator 3578 as determined by radio fixes from May 18 to September 17, 1969.

1969. On July 5 the transmitter was found in a clump of wiregrass *(Spartina patens)* near the nest site. When found the transmitter was inoperative, probably as a result of damage to the wiring of the antenna when the collar was pulled off the head of the alligator. From the limited data obtained from this unit, minimum home range was determined to be 12.4 acres (Figure 3).

Period I - Courtship and Possible Breeding. Nine and a quarter acres was the minimum range of the alligator during the courtship and breeding period. The alligator was located in marsh lakes during the majority of this period, as 75 percent of the fixes on her were located in open water bodies.

Period II - Nest Construction and Egg Laying. Locations plotted during the nest construction and egg laying period indicated that 82 percent of this alligator's activities were confined to dens within a 2.1 acre area around the nest site. The areas used in Periods I and II did show some overlap; however, the majority of the fixes on Unit 9 were in the marsh proper during Period II.

Period III - Incubation (Subperiod A). As was demonstrated by other alligators followed, Unit 9 remained within a one-third acre area surrounding her nest site during the 11 day period immediately following egg laying. The range for this female during the remainder of the incubation period could not be plotted because the transmitter was slipped over the head of this female. We returned to this nest after the allotted time for incubation and found she had returned to the nest and liberated the young.

Alligator No. 3580. A six foot 4¼ inch alligator was instrumented with transmitter number 1 on July 22, 1969. Transmitter number 1 was followed until November 10, 1969, when we assumed the female went into the winter dormancy period because of cold weather. The minimum home range for alligator 3580 was determined to be 6.4 acres (Figure 4). This alligator was captured at her nest site on July 21. Prior to transmitter attachment, alligator 3580 was extremely aggressive and defended her nest strongly against persons conducting this study. However, after the transmitter was attached, she did not attempt to guard the nest.

Period III - Incubation (Subperiod B). The range of this alligator during the late stages of incubation was demonstrated to be 6.2 acres, with 100 percent of the female's activities being confined to small marsh holes and established dens in the vicinity of her nest site.

Period IV - Post Hatching. Fixes plotted for Unit 1 from August 31 through November 10 indicated that this female spent 100 percent of her time within a three acre area around the nest. This area was predominately a *Spartina* marsh with a few small ponds and alligator dens. Unit 1 opened the nest, thus releasing her 1969 hatch. The young were seen at one of her dens located at the base of the nest.

Alligator No. 3583. This seven foot 10¼ inch alligator proved to be a "hard luck" animal to persons conducting this study. She provided the least amount of data for any of the alligators followed. Unit 6 was captured on May 27, instrumented on May 28, and released in the same location. The transmitter functioned until June 11. Signs around the den indicated that this female remained in the general area of her release site for approximately a week after the last signals were received. On June 22 we attempted to capture this alligator from her well. We were successful in moving her from her den but missed capturing her as she ran from the well and escaped into a bayou. Unit 6 was recaptured on July 6 in a canal 4,100 feet from her original capture site. Whether this female moved because of our interference or because of her own accord remains to be seen. Old transmitting Unit 6 was removed and she was outfitted with a new unit (number 3). However, Unit 3 operated less than one day. Examination of the components of Unit 6 revealed that the batteries were still in good shape and that the unit malfunctioned as a result of corrosion in the wiring.

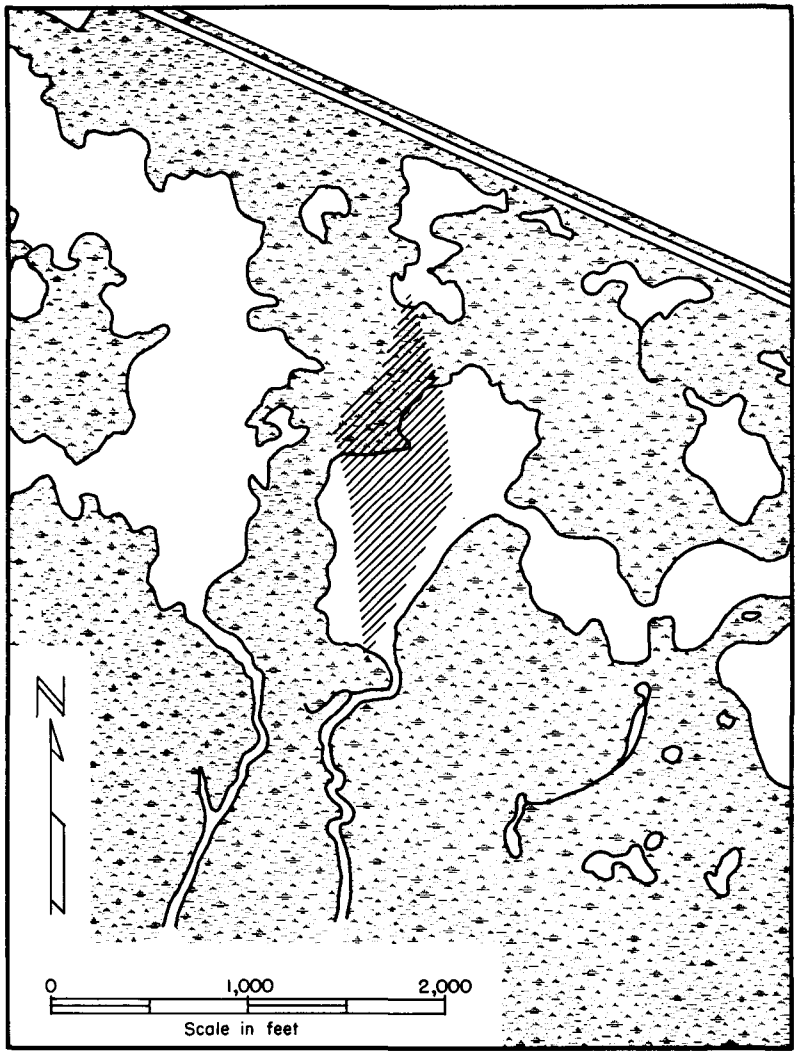

Figure 3. Minimum home range of 12.4 acres for alligator 3577 as determined by radio fixes from May 18 to July 4, 1969.

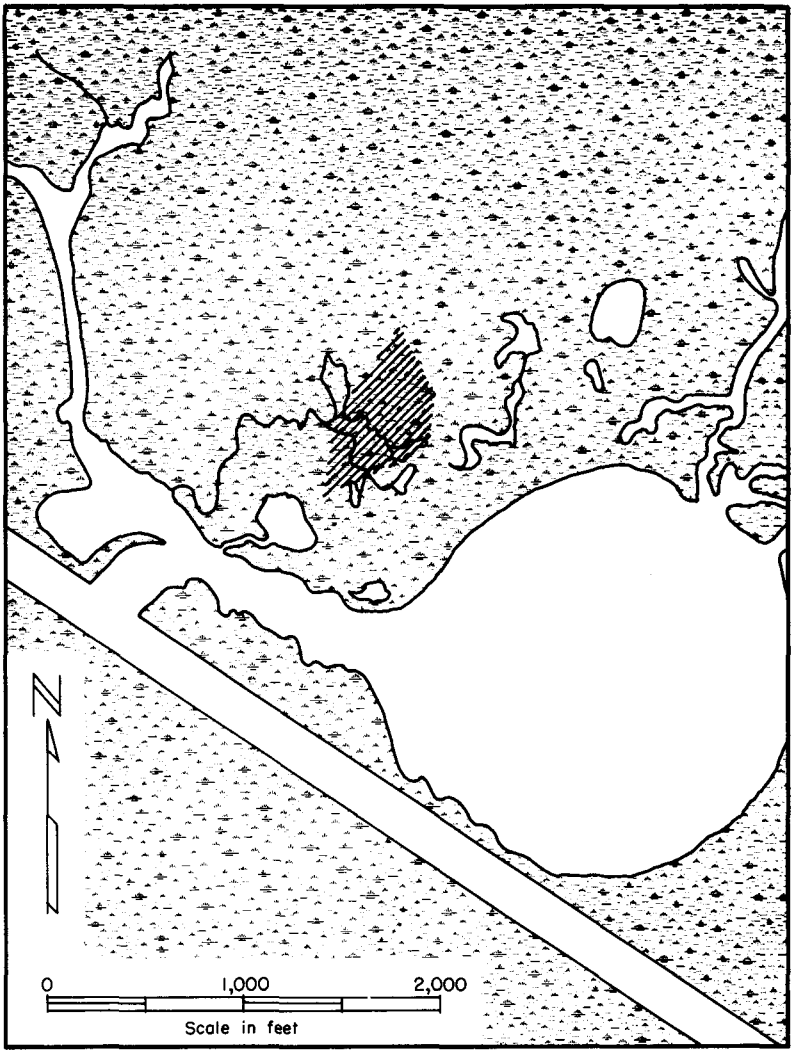

Figure 4. Minimum home range (6.4 acres) for alligator 3580 as determined by radio fixes from July 22 to November 10, 1969.

Telemetry data for the 15 day period during which Unit 6 functioned indicated that this alligator occupied a minimum range of 1.2 acres for the period (Figure 5). One hundred percent of her time was spent in a couple of dens located within this marsh area.

Movement According to Periods

Daily movement was fairly limited for all of the animals followed during this study. The longest daily movement recorded was 1,500 feet. However, we feel that this movement, which occurred the day following release, may have been greatly influenced by our handling. It seemed to take two to three days for the individuals to readjust after being instrumented and released.

Average daily movement for individual animals during the course of this study ranged from a low of 45 feet per day to a high of 111 feet per day and averaged 79 feet for the five alligators.

Generalized movement patterns will be characterized according to the four periods as broken down for this study in the discussion that follows.

Period I - Courtship and Possible Breeding. The period of courtship and breeding showed the greatest amount of daily movements and also the largest range sizes when compared to the other three periods. Average minimum range size for the females under study in Period I was found to be 7.76 acres. Movements during this period were closely associated with the deeper marsh lakes, ponds, and bayous (large, open water areas). An average of 79 percent of the fixes recorded on all alligators studied during Period I were in open water areas. These open lakes, ponds, and bayous offer the least amount of restriction to movement. Chabreck (1965) stated in his study that the greatest amount of movements in adult females occurred in the spring (April and May). This information lends emphasis to what we have previously noted in our alligator pen studies; that courtship and copulation takes place in the water.

At the start of this project, readings were taken daily on each animal under study; however, as the study progressed it was later found that this second group of readings were not necessary, as average daily movement was found to be only 79 feet.

Period II - Nest Construction and Egg Laying. With the exception of Unit 4, range sizes during this period were very small. Daily movements during the period were less than that plotted for Period I, but greater than for the incubation and post hatching periods. The majority of the longer daily movements recorded during this period occurred just prior to nest construction. During this 20 day period, the percent of fixes on the four alligators monitored were averaged and showed that 85 percent of their activities were confined to small holes and wells within a 5.16 acre area around the nest site. One female under study was noticed to travel some 1,250 feet from the courting and breeding area to where she selected a nest construction area. However, two females selected a nest site near the area of courtship and breeding and the area used in Period II overlapped the area of Period I.

Period III - Incubation. Daily movement during the first week and a half of incubation was smaller than for any other time during the entire study. The three females monitored during this one and a half weeks were found to spend 100 percent of their time within a one-third acre area surrounding the nest site. Daily movements during the remainder of the incubation period centered around the female's den locations with short daily movements from one well to another well. Ninety percent of the locations plotted for all alligators during the 71-day incubation period were in dens and wells maintained by the females.

As the incubation period progressed, the females were found to move greater distances away from the nest. Two females moved as far as 1,010 and 1,900 feet from their respective nest locations. These females spent the remaining months of July and August in an average minimum range of 4.23 acres.

Period IV - Post Hatching. Daily movements during this period were also largely centered around the female's den locations. Short movements were

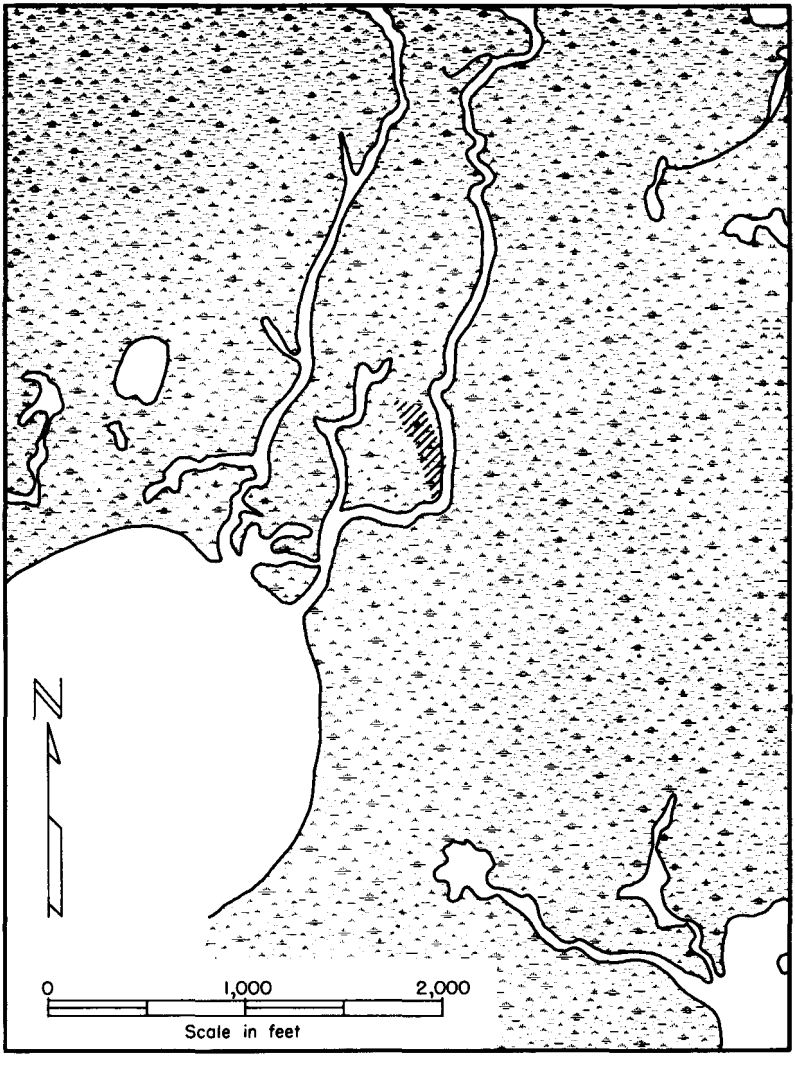

Figure 5. Minimum range for a 15-day period, representing 1.2 acres, from May 28 to June 11 for alligator 3583.

recorded when the female moved from one well to another. Ninety-six percent of the fixes during this period were at den sites. Only one alligator remained in the vacinity of the nest during the post hatching period. Minimum range covered during the period averaged 1.8 acres, quite small considering the period covered 72 days. In comparison, only the one-third acre range for the first week and a half of incubation was smaller. We feel safe in assuming that the females overwintered in their well established dens, although radio contact was lost in mid November.

Unit 1 was generally located in close proximity to the nest during the period. However, the other two alligators followed during Period IV were quite far removed from their respective nests.

Nesting

Four of the alligators equipped with transmitters nested during the study and it is probable that the fifth female under study also nested. Three of these females were equipped with transmitters during the period when copulation probably took place, indicating that the collar assembly did not adversely effect courtship and breeding. A 50 percent nesting success was obtained from the nests under study. This is somewhat below the 68.3 percent found by Joanen (1969). However, this could be due to the small sample size.

Effects of Handling and Transmitter Attachment on Alligators

Movements during the first week after collar attachment were generally found to be greater than for any other time during the study, indicating that the considerable amount of handling associated with outfitting an alligator did have a short term effect on the animal. This short term movement was exactly the opposite of that reported for deer and wild turkey, where deer and turkey reportedly remained in small areas with only very limited movement for the week following instrumentation.

Only one alligator was recaptured so that the animal could be checked for possible injury caused by the collar assembly. This animal was recaptured 40 days after the collar was attached and showed no external signs of abrasion as a result of the transmitter assembly.

Environmental Factors

Temperature. As would be expected for a poikilothermic animal, seasonal temperature changes have a difinite influence on the activities of alligators. Chabreck (1965) reported that alligators go into a partial hibernation during periods of cold weather, only surfacing periodically to breathe.

Giles and Childs (1949) reported that alligators on Sabine National Wildlife Refuge tended to move from the shallow open water areas to the marsh in June because the water in these shallow areas became excessively hot. They also noted that in natural tidal marsh, summer movement was from the shallow marsh to deep open water in response to low water levels and high temperatures in the marsh.

Seasonal changes in activity patterns noted during this study strongly suggested that temperature had a direct influence on alligator activity. During the spring and fall, when temperatures ranged from cool to moderate, more successful fixes were recorded during the period around mid day. Conversely, during this summer, our success was higher in locating the alligator's position at night and near dawn, indicating that these females were more active during the cooler periods of the day.

It is very difficult to correlate the choice of a particular habitat preference as a direct response to temperature. Movement during the courtship and breeding period (cool days of late May) was confined to open water areas. The alligators spent the greater percent of their time in dens in the marsh during the remainder of the period (summer, fall, and early winter) covered during this investigation. Perhaps the deep water and soft mucky bottoms of their dens served as a buffer to the extremes in temperature fluctuation noted during the summer and late fall months.

Water Levels. Giles and Childs (1949) reported that mature female alligators will seek out the margin of ridges for nesting sites if abnormally high water levels are experienced during the nesting season.

Chabreck (1965) related that alligator movement increases whenever marshes are flooded as a result of excessive rainfall and high tides. He further reported that immature alligators seem to respond to flooding more than do adults.

Water levels during the early stages (spring) of this study averaged about two inches above the marsh floor. This corresponded to the period when the greatest amount of movement occurred during the study. It seems reasonable to assume that it would be much easier for an alligator to move about when the marsh is flooded.

During the early summer period, the water depths were at about marsh floor level. Movement during this period was generally quite restricted.

The late summer period experienced water depths (+2 inches) comparable to the spring period. However, movement was considerably less than in the spring period.

Water depths were at their lowest during the post hatching period. Movements recorded during this time was very restricted.

Attempts at locating the alligators during cloudy and/or windy days were generally not as successful as on field trips when the weather was more favorable. We could not ascertain if this was due to a decrease in alligator activity during this time or whether it was due to interference in the receiving capabilities of our unit.

Management Implications

Habitat Management. Movement and activity data, as analyzed for this study, indicated that the control of water levels and percent water coverage is important in certain phases of the life history of the female alligator. The tendency of the females to selectively seek out open water areas during the courtship and breeding period demonstrates that this is an important consideration to be made in the management of the alligator. The maintenance of stable and adequate water levels in the marsh proper is also desirable.

The use of weirs as a management technique in marshes affected by tidal exchange were found desirable in stabilizing water levels, reducing turbidity, and restricting rates of tidal exchange (Chabreck and Hoffpauer, 1962). Weirs would permit the flow of tide water back and forth over the structures, yet prohibit excessive drainage of the marsh ponds, potholes, and lakes during periods of low tide. This type of management would maintain the open water situation needed by the adult female during the period of courtship. Also, the use of weirs would enhance the value of the water areas for aquatic forms of life which are so important in the alligator's food chain.

Harvest. Giles and Childs (1949) stated, "Some protection is warranted during the crucial period between egg laying and hatching of the young. If the female is destroyed then, there is little likelihood that the eggs will hatch. The degree of protection needed in the nesting period may depend largely on the amount of control over hunting activities. Where no hunting supervision is possible, it would be advisable to establish a closed season from mid-June until mid-September. Breeding females, on the Sabine Refuge, are seldom killed in the canals and bayous. Concentration of hunting in such accessible areas holds the loss of breeding population to a minimum; most of the breeding alligators are some distance back in the marsh where they must be hunted on foot."

Harvest regulations which resulted from this study and are aimed at protecting the female segment of the breeding populations include:

1. Set the season to begin in mid-September (post hatching) and continue to winter dormancy.
2. Confine hunting activities to bayous, canals, and open water lakes.
3. Prohibit all hunting in the marsh proper at anytime of the year.

By setting the season after the young have hatched, the new hatch will be available for restocking should the female be harvested.

The data obtained from this study indicates the nesting female alligators use the open water areas primarily during the spring of the year; however, these females also were found to use this type habitat occasionally during the nest construction and late incubation periods. By restricting hunting to canals and bayous in the post hatching period, a significant part of the nesting population should be protected.

SUMMARY

A study was conducted on Rockefeller Refuge from May 18, 1969 through November 10, 1969 to gather information on the movements and activities of adult female alligators. During this study, five adult females were equipped with collar-type transmitters and monitored over a period of 177 days with a portable directional receiver. Tracking of alligator movements normally involved the use of a hand held antenna from 15 permanent listening stations. At the time a signal was received, the directional of the signal was determined by compass bearing and the station number and compass bearing recorded. At least two compass bearings were made for each animal whenever possible. A total of 411 compass bearings were made during the 177 day study.

Due to the malfunction of the unit on one alligator, information concerning home range size was obtained for four alligators. Minimum home range sizes for these alligators measured 6.4, 12.4, 24.2, and 41.0 acres. Two of the alligators were found to have minimum home ranges which overlaped. The range of overlap occurred during Period I (courtship and breeding). Activity patterns determined when these females were in close proximity indicated that there was no competition between these animals during this short interval of time.

Daily movements were fairly limited for all animals under study. The longest daily movement recorded was 1,500 feet. The minimum average daily movement for all alligators under study was 79 feet.

Each individual alligator demonstrated varying degrees of movement during this investigation. However, general trends in movement were similiar for all of the alligators whenever movement was considered in relation to the four time periods as used for the study. It was found that two distinct marsh types were used by all of the alligators monitored. During Period I, the females were found to use open water bodies on 79 percent of the fixes recorded. For the remainder of the study, alligators were closely associated with the marsh proper, spending the majority (89.9 percent of the fixes plotted) of their time in isolated dens. This movement from open water bodies to marsh dens was found to take place in early June or just at the onset of Period II (nest construction and egg laying).

The greatest amount of movement was recorded in Period I (courtship and breeding). This period showed the greatest amount of daily movement and also the largest average range size (7.76 acres) when compared to the other three periods.

Recommendations regarding harvest should consider the activity periods of the nesting population. As this segment of the population makes up approximately four to five percent of the total population (Chabreck, 1965) every effort should be made to restrict the harvest on nesting females. A hunting season during the post hatching period in canals, bayous, and lakes would allow a harvest on immature alligators of both sexes and adult males.

The effects of handling and the transmitter attachments on alligators had its greatest effect with regard to movement during the first week after release. Four out of the five females studied nested. Also, three females were equipped with transmitters during the period when copulation probably took place, indicating that the collar assembly and antenna had little effect on courtship and breeding.

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